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SMART CAR

Arduino based Shape, Color and Laser follower Using Computer Vision

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ABSTRACT

The main idea of the project is to develop a semiautonomous robot that can be controlled from a remote location and it has the intelligence to capture, analyze, and send visual data back to the controlling device. The robot works on the concept of image processing. It has a camera attached on top of it. The project is based on both hardware and software. The project uses Arduino UNO microcontroller, to interface hardware with a laptop. The soft wares used in the project are openCV, a library, used for image processing, and Visual studio which is used for coding and as an interface between microcontroller and processor. C++ language was used for coding.

Keywords-*Smart Car; Arduino, Computer Vision; Laser Follower*

I. INTRODUCTION

Computer vision is a technique in which data is collected from an image capturing device and then processed using appropriate software to analyze and process that data to get the desired results. These include background subtraction, object detection, color detection, and face detection, filtering out of noise and several other formatting tools. It helps in providing artificial intelligence to a machine since data can be captured and processed in real time without human intervention to perform a designated task. We have used this technique in our project Smart Car to give it the ability to follow an object, shape or color using a basic robot prototype and also detect a laser pointer in the front to point its own laser near it.

Objective	Requirements
1. Read the color →	Webcam , Visual studio and OpenCV library
2. Interaction between Image read(color detected)& bot? →	A User Interface between processor and the bot
3. Move the bot towards the color , object . →	Arduino Uno , Motor Driver , DC Motors
4. Laser Detection →	Motor shield , Servo Motors and a laser .

II. HARDWARE, SOFTWARE AND CODING COMPONENTS

The project uses a combination of the hardware and software to function. The Arduino UNO board acts as an interface between the two, where one part of the calculation is send to it via serial port, and the other part is flashed into the board. An interaction between the two produces the desired results.

A. Hardware Part

The main hardware component in this project is the Arduino Uno microcontroller, the heart of the entire project. Arduino Uno microcontroller is based on ATmega328.It has 14 digital input/output pins, 6 analog pins, a USB connection, power jack and a reset button. The Uno differs from all preceding boards in that it does

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not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 programmed as a USB-to-serial converter.
Apart from the Arduino microcontroller, the project has DC series motors, servo motors and a Laser. The DC motors are used for the forward/backward movement of the smart car. DC motors are widely used in robotics because of their small size and high energy output. They are excellent for powering the drive wheels of a mobile robot as well as powering other mechanical assemblies.
The servo motors used are mounted on the top of the bot, which are used for the movement of the Laser. The laser and servo motors work together in sync. Whenever the Laser is pointed in a particular direction, the servo motor moves in accordance with the laser.

B. Software Part
The project uses a combination of 3 different softwares to make it work: OpenCV, Visual Studio, and a customized GUI. The smart car is mainly based on the concept of image processing. OpenCV is the software used for image processing. OpenCV is a library of programming functions mainly aimed at real-time computer vision released under a BSD license.. It has C++, C, Python and Java interfaces and supports Windows, Linux, Mac OS, iOS and Android. OpenCV was designed for computational efficiency and with a strong focus on real-time applications. OpenCV software has various advantages over Matlab. They are mainly cost, speed, ease of use, portability and easy to debug.
Visual Studio is a complete set of development tools for building ASP.NET Web applications, XML Web Services, desktop applications, and mobile applications. Visual Basic, Visual C++, Visual C#, and Visual J# all use the same integrated development environment (IDE), which allows them to share tools and facilitates in the creation of mixed language solutions.

Fig. 1: the GUI made using Visual Studio

C. Coding Part
Coding forms a very large part of this project. Codes were given to select colors from the image by providing the required minimum and maximum RGB components. Out of this processed frame, codes and algorithms were used to separate out the circular shape. This code, "cvHoughCircle" forms the Heart of the project and is given as:

```
p_seqCircles = cvHoughCircles
(p_imgProcessed,    // input image, black
                       and white
p_strStorage,      // provide function with
                   function return a pointer
                    to a CvSeq object
CV_HOUGH_GRADIENT, // two-pass algo for
                     detecting circles
2,                 // size of image/ 2 =
                   "accumulator resolution"
 p_imgProcessed->height/4,  // min distance
            in pixels between the centers of
                    the detected circles
100,     // high threshold of Canny edge
         detector, called by cvHoughCircles
50,      // low threshold of Canny edge
         detector, called by cvHoughCircles
10,      // min circle radius, in pixels
    400); // max circle radius, in pixels
```

When these circle have been detected using the code, another code "cvCircle" is used to draw circles around the detected objects, by using the coordinates and radius as returned by cvHoughCircle.

III. MOVING THE VEHICLE

Using a camera attached to the Car, the image is scanned and processed using the OpenCV Library and Visual studio coding (In real time).These scanned images are processed to analyze and find the object we need to follow and further depending upon the results of the processing, commands are given to the motors to maneuver the vehicle to follow the object to be followed.

Working:
For this each frame was divided into 3 parts, making the entire frame to be divided into 3 columns. This made it possible to find the exact part in which the object was detected and then the motors that move the robot at the detected part.
This technique was used since communication with the Arduino and motors are based on serial transmission of

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data so only one bit can be transferred at a time. These 3 cells were named using a single character (l,f,r,s) and thus made serial communication effective in transmission of data consisting of x-axis.
The separate code written into the Arduino UNO searches for the bit transmitted into it from the CV++ and then sends the appropriate instructions to the DC Motors to move on the cell detected.

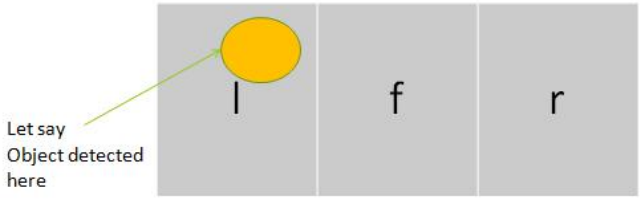

Figure 2

IV. MOVING THE LASER

The camera on the vehicle is capable of detecting various memory storage, makes shapes and color. Since the intensity of the laser is very high, it can easily be differentiated by Computer Vision. It can be seen as a very small bright white dot with a very high intensity.
Using OpenCV and VC++ we will be able to calculate the exact position on a 2D axis, that is with x and y coordinates. The content of the x and y coordinates will be transferred to 2 perpendicularly placed Servo motors. These servo motors will be able to point a Shooting device, or another laser pointer at that same point, by giving the laser two degrees of freedom.

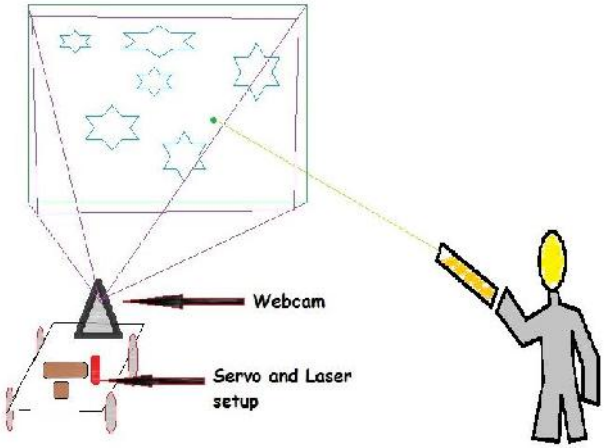

Figure 3

Working:
For this each frame was divided into a 6 by 9 matrix, having 6 rows and 9 columns, making the entire frame to be divided into 54 small cells. This made it possible to find the exact cell in which the laser pointer was detected and then point the laser mounted on the robot at the detected cell.
This technique was used since communication with the Arduino and Servos is based on serial transmission of data so only one bit can be transferred at a time. These 54 cells were named using a single character and thus made serial communication effective in transmission of data consisting of two axis coordinates, both the x-axis and the y-axis.
The separate code written into the Arduino UNO searches for the bit transmitted into it from the CV++ and then sends the appropriate instructions to the servo motors to point the laser on the cell detected.

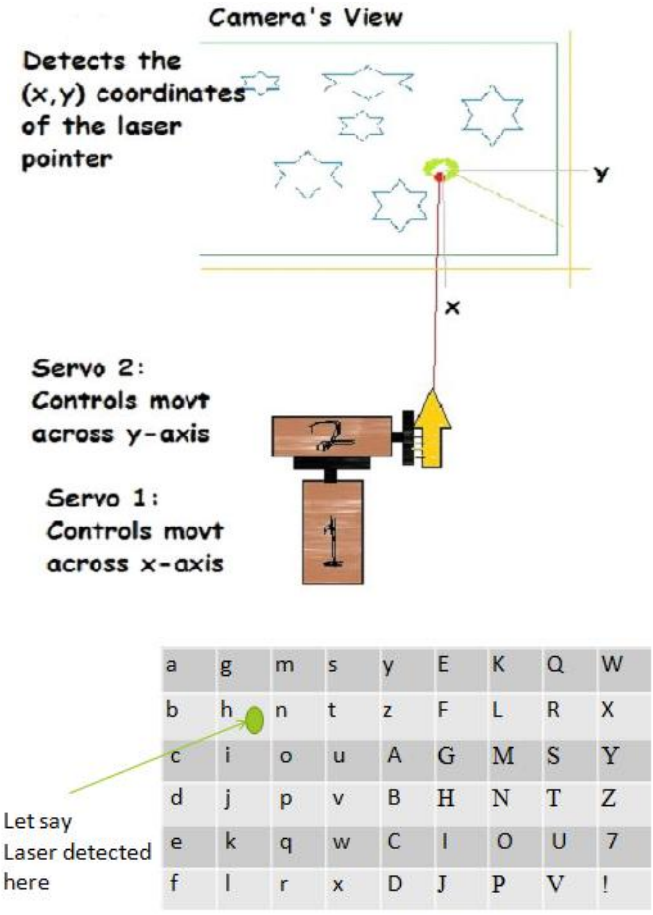

Figure 4: To show the Laser Matrix

V. APPLICATION OF THE PROJECT

This project includes research and development of an intelligent vehicle that is capable of following a moving object or another vehicle. It will be able to scan and process various colors, shapes, and types of objects to be followed. It provides a new innovative attack system for military purposes: in which it will shoot the firearm on the point wherever the laser pointer is pointed using its scan and processing technique and thus giving a next-gen autonomous attacking capability to any firearm. It can be used in Drones and UAV (Unmanned Aerial Vehicles) to shoot using help of the lasers to accurately determine the target and shoot precisely and automatically.

VI. CONCLUSION

Thus we have incorporated computer vision and arduino in the basic robot prototype to give it shape, color and object following capabilities that too without human intervention. Also a new prototype to detect and shoot a laser on a laser target was implemented successfully.

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